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Experience with FOLIDOL®* Oil Spray
against brown scale (*Eulecanium corni* Bche.)
on grape vines

by Rudolf Roesler

There is no difficulty in controlling brown scale in fruit growing. The result of a 100 % mortality of overwintering young larvae has for some time past already been one of the conditions required for the official approval of a winter spray. This effect is easy to obtain in laboratory tests and also in field trials because the young scales settle fully exposed on the bark of stems, boughs and branches, and can thus be fully controlled by careful spraying. In viticulture, however, the situation is quite different. A large percentage of young scales overwintering on vines settle on old wood, deeply concealed between the coarse fibres of the old bark where they are difficult to reach with spray solution. This explains why controls of brown scale on grape vines by conventional winter spraying do not always produce satisfactory results. In the "Vorderpfalz" vine growing district where for many years there has been severe occurrence of brown scale especially on heavy soil and in flat parts, Jancke (1953) established in tests (unpublished) he conducted that fruit tree hydrocarbon oils are not suitable for controlling this pest. The best results he obtained were given by DNOC sprays, especially by dinitrobutyl phenol.

In Spring, 1957, the author carried out a series of field trials with oleo-phosphoric esters; this group of products had already produced a very good effect against young brown scales in laboratory tests. Dinitrobutyl phenol (DNBP) and dinitrocresol (DNC) were included in these field tests as comparison products. Spray applications were carried out in three vineyards, each with 2—3 replications, on March 25, 1957. Approximately 300 vines were treated with each product. The first check four weeks after the spray applications showed that all products had given almost a 100 % control of exposed young scales on 1 to 3 year old wood. On the other hand, it was found by carrying out spot checks that many scales concealed under the bark of old wood had not been affected by the treatment, and were still living. As it was not possible for technical reasons to remove bark on large numbers of vines for the purpose of making an exact count, another method of evaluation had to be sought. During the last days of June, masses of freshly hatched young scales of the new generation appeared under the bark of the old wood, not only on untreated vines but also in the treated plots even though in fewer numbers. The young

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scales that emerged from the old wood practically all affixed themselves on the bottom leaves close to the stem, thus rendering it possible to carry out a further evaluation. Counts were taken on 120 leaves for each product; these leaves were sampled very close to the old wood. The untreated plots were found to be colonized by 21,661 scales, i. e. an average infestation of 180 scales per leaf. In order to check these results which are given in Table 1, the rate of infestation was again established in February, 1958; for this purpose 40 samples were taken for each product. Counts were taken in each case at the base of the annual wood as far as the 2nd eye and down to 4 centimetres of the old wood located underneath it, because these parts are usually the most densely colonized.

Table 1 (% efficacy):

	Leaf count in July	Infestation check in the following Winter
FOLIDOL Oil Spray 0.5 %	96.5	91.8
DNBP 0.75 %	91.9	85.9
DNC 1 %	86.2	77.1

The best effect was given by FOLIDOL Oil Spray, followed by dinitrobutyl phenol and dinitrocresol. The worst effect was recorded for fruit tree hydrocarbon oil (heavy oil) which was included in the tests only as a subordinate product and for this reason is not included in the table; it only produced an effect of 73.6 %. These results very largely agree with the findings of Jancke (1953) and prove that the success of the control depends to a considerable extent upon the penetrating power of the products. The oil products have an especially good wetting power whereas the dinitro products, as water-soluble salts, penetrate very well into the bark which at the time of spraying is usually somewhat moist and porous.

The tests were repeated in 1958; they included applications of the following products: FOLIDOL Oil Spray, oleo-phosphoric ester product X, dinitrobutyl phenol, dinitrocresol, yellow oil and GUSATHION®. Spraying was carried out on April 28, 1958; 125 vines were treated with each product in 2 plots, and 3 plots of 25 vines each were marked out as untreated checks. At the evaluation in July, 200 leaves (growing close to the stem) were sampled per product to determine the infestation rate. In the untreated checks, counts on 200 leaves showed that 22,168 young scales were present, i. e. an average of 110 scales per leaf. A second test was carried out (spraying on May 7, 1958), including only the two oleo-phosphoric ester products; 220 vines were treated with each product in 2 plots. 20 vines were left as untreated checks. 200 leaves were sampled per product at the check in July. The untreated check showed an infestation of 22,778 scales on 200 leaves, i. e. an average of 113 scales per leaf.

Table 2 (% efficacy):

	Leaf count in July
1. Spraying on April 28, 1958	
FOLIDOL Oil Spray 0.5 %	96.8
Oleo-phosphoric ester product X 0.5 %	98.3
Yellow oil 2 %	98.9
DNPB 0.75 %	97.8
DNC 1 %	99.6
GUSATHION 0.2 %	97.5
2. Spraying on May 7, 1958	
FOLIDOL Oil Spray 0.5 %	99.4
Oleo-phosphoric ester product X 0.5 %	98.9

A most striking feature is that in contrast to the preceding years, practically the same effect was given by all products in 1958; in fact, the effect appeared on the whole to have increased somewhat. The perceptibly greater effect of the dinitro products can be attributed only to the weather. In 1957 during the period starting one week prior to spraying until 3 weeks after the applications, 34.6 mm of rain fell corresponding more or less to a normal monthly mean. In 1958, the amount of rainfall registered in the same period was 69.5 mm. The bark of the vines was moist practically all the time for a period of several weeks, and the water-soluble dinitro salts were able to penetrate deep down into the porous bark. The overall better effect is undoubtedly due to the extremely late spraying date. On May 7, 1958 when the oleo-phosphoric esters were sprayed, the plants had already budded. No injuries to plants were established, in fact not even when sprays were applied still later after the leaves had already unfolded. Therefore, it appears possible to apply the phosphoric ester products also after budding. The effect of GUSATHION is most noteworthy; this product was used for the first time in "winter spray" applications against scales, and gave a good result here, too. The application of this product against scales during the growing period will be reported on in another paper.

Summary of tests:

1. The control of brown scale on vines is made very difficult due to the fact that many scales live under the bark of old wood where they are not readily accessible to the spray wash. The success of an application depends very largely upon the penetrating power of the product used.

2. The oleo-phosphoric esters produced a very good effect in all cases.

3. The dinitro products are not so effective as the oil products, unless of course the penetration of the water-soluble salts is assisted by very damp weather.

Advantages and disadvantages of oleo-phosphoric ester products

by Herbert Engel, Freiburg

In 1949, Linden (5) proposed that orchards should be sprayed in winter with parathion since the residual effect of this active substance on bark is sufficiently persistent to kill the dormant stages of insects overwintering on fruit trees. Proof of an ovicidal and ovolarvicidal effect against eggs of aphids, winter suckers and winter moth was produced by Holz (3). The idea of using a summer insecticide for winter spraying was too revolutionary for it to be realised immediately. Therefore, parathion was neither recommended nor used for winter spray applications.

As the proposal of Linden was disregarded, the developments first took a different course. The carbolineum oils or yellow sprays used for winter applications are suitable for reducing the colony of pests on a treated tree but they do not give control of such species as apple blossom weevils and aphids that migrate later to the treated trees — that is if these species have not overwintered on the treated trees — nor do they control larvae of browntail moth concealed in their winter nests. In fact postponement of winter spraying to the latest possible date results only in a partial elimination of this pest population. This disadvantage of winter spraying could only be offset by using an insecticide in the pre-blossom spray applications. Besides lindane, parathion seemed to be especially suitable for this purpose, its range of action and translaminar effect already having been tested against a number of major fruit tree pests. The inclusion of an insecticide in the pre-blossom spray applications proved to be of practical advantage, and on the other hand showed that by doing so, winter spraying was superfluous. For fruit farming to be a sound economical practice it is essential not to carry out sprays that do not serve any practical purpose, and in view of this the question raised by Schneider (6) as to whether winter spraying under these circumstances is at all necessary, was most justified. Since then, the subject of winter spraying has continued to be a matter for lively debate.

The question whether winter spraying is necessary or not is incorrectly formulated. Instead it should be worded as follows: "Under what circumstances and on what fruit species can winter spray applications be omitted?" Pre-blossom spray applications in pome fruit plantations, like all later measures on these fruit species, must be carried out within a very limited period of time. Thus in contrast to winter spraying, the pre-blossom spray applications are dependent upon the time factor. Therefore, orchardists not carrying out winter sprays must have not only fast-working machines but also the necessary amount of time for pre-blossom spray applications. This means that in all instances where these conditions apply, winter spraying can be omitted without any misgivings. In practice, this will be the case primarily in commercial fruit growing, to a lesser degree on farms where orchards are also kept, and hardly at all in smallholdings and gardens. In pome fruit plantations where infestation of dandelion is severe, the first pre-blossom spray can be carried out when the dandelions flower in those years when budding is delayed. To avoid harming bees, spraying should in such cases be carried out after the

flowers have closed, in other words after about 6 p. m., or else orchardists should keep to the practice of winter spraying.

Even if winter spraying can be replaced on principle by pre-blossom spray applications in pome fruit growing, it still remains a most essential practice for reducing populations of overwintering pests in plantations where stone fruit and berries are grown. Here the period between budding and flowering is so short that often a pre-blossom spray application can hardly be considered which means that the practice of winter spraying must be retained.

Winter spraying in the form known to date, is nothing more than a preventive measure which is carried out under the assumption that the tree to be treated is colonized by pests. In economical fruit farming, such winter spray applications are justified only when the existing population of pests is large enough to constitute a danger to the tree and its crop. In actual fact, occurrence of aphids, suckers, winter moth, ermine moth etc. varies greatly in the different years so that the necessity and economy of winter spraying are sometimes debatable. This is even more applicable in cases where the pest population is so small that it can be kept in check by beneficial insects, which has been demonstrated on untreated trees. This fact is especially emphasized by those recommending the practice of winter spraying, and it is pointed out that winter sprays, in contrast to those insecticides used in pre-blossom applications, either protect the predators or else cause little or no harm to them at the time of application. However, a question of great importance to orchardists who would like to save a spray application, is what degree of infestation and what pests are suppressed by predators acting alone. Bachmann and Vogel (1), through their studies of sampled branches, have contributed towards finding a solution to this problem. Checks on sampled branches permit a forecast to be made of the probable pest infestation, thus indicating whether a winter spray application will be necessary or not. This method of obtaining an indication of the probable occurrence of certain pests, namely by examining sampled branches, has much in its favour. It is extremely valuable to both advisory organisations and warning services. When such checks are conducted, winter spraying need no longer be a preventive practice but like all other crop protection measures in fruit farming, can be carried out as an aimed control. This corresponds to the demands of orchardists who are prepared to carry out spray applications only when these are necessary and it is certain that they will prove successful and economical. At present crop protection practices in fruit farming are given consideration from the economical aspect chiefly by professional orchardists although it must remain the aim of one day being able to assume that the same policy is pursued by all fruit growers including owners of smallholdings.

Oleo-phosphoric ester products constitute a step forward in this direction. In addition to a phosphorus insecticide such as diazinon, malathion or parathion, these products also contain a mineral oil. The purpose of the oleo-phosphates is to replace the winter sprays used to date. Due to their mechanism of action, however, application of these products is restricted almost exclusively to the period shortly prior to and up to bud breaking. The Bayer product FOLIDOL OIL SPRAY which contains parathion has a more intensive ovolarvicidal effect than other oleo-phosphates but this should not infer to growers that it can be applied at any other time. The oleo-phosphate products do not yet have a name in German which is to the point. To call them late

winter sprays because they are applied later than the usual winter sprays would be incorrect since they can only be applied with success at the time of bud breaking, i.e. from bud swelling to the mouse-ear stage. The oleo-phosphates differ so clearly from the winter sprays both with respect to the time of their application and in the nature of their action that only a completely new name can do justice to their character. Therefore, it would seem correct to call these products in German "Austriebsspritzmittel" (bud burst sprays) as suggested by Bender, Meersburg. This term is new, and appropriately covers the time of application for this group of products.

The bud burst sprays have become rapidly established both in Switzerland and in Germany. The low concentration at which they are applied (FOLIDOL OIL SPRAY = 0.5 %) permits them to be marketed in small packings which was hardly possible for carbolineum oils, for example. Owners of small-holdings who in the past were mainly dependent upon joint purchases of winter sprays or else had to forgo this treatment, are now in a position to carry out this first fruit tree spraying themselves. The bud burst sprays are readily soluble in water, do not cause burns on buds or undersown crops, do not stain clothes, walls of buildings or fences, and do not attack the skin. It is particularly these features which have helped oleo-phosphate insecticides to become established more quickly than was presumed.

Bud burst sprays do not feature the long application period of winter sprays although growers hardly made use of this advantage of carbolineum oils, which also includes the possibility of carrying out sprays in frost conditions; as shown by extensive experience in joint controls of San José scale, growers tended to delay the date of spraying as long as possible so that they could carry out treatments in March when the days are longer and warmer. In this connection it should not be forgotten that it is necessary anyway to delay the time of spraying when DNC products are used if apple blossom weevils are to be controlled, too. The time available for such a treatment is limited thus forcing orchardists, in the same way as with bud burst sprays, to carry out a more or less time-governed application. Late spraying of DNC products in mixed plantations where drift of spray mist to neighbouring trees and undersown crops cannot be avoided, is never a completely harmless practice. With oleo-phosphate insecticides, there is undoubtedly less danger of this happening, if at all. Late winter spraying with DNC products can, therefore, be regarded, as far as the application time is concerned, as a form of transitional practice until the bud burst sprays are applied.

FOLIDOL OIL SPRAY, as one of the oleo-phosphates on the market, possesses an extremely large range of action. In tests where this product was sprayed shortly prior to (March 31, 1958) and during bud burst (April 8, 1958), the following pests were killed by FOLIDOL OIL SPRAY (applied at 0.5 %) (mortality expressed in %):

Date of treatment	Apple blossom weevil	Aphids	Suckers	Winter moth	Ermine moth	Bud moth
31. 3.	75	90	96	73	60	87
8. 4.	80	98	97	80	80	88

The differences in the effect of FOLIDOL OIL SPRAY as shown here very clearly indicate that the bud burst sprays are most effective when the dormant stage of the pests has practically ended. The time when this happens is determined approximately by the budding of fruit trees. Applied at the same concentration of 0.5 %, FOLIDOL OIL SPRAY is also effective against brown scale and San José scale. For applications before budding, in other words along the lines of the past practice of winter spraying (February-March), FOLIDOL OIL SPRAY is the only one of the oleo-phosphate insecticides that is useful for this purpose. The results obtained in such an early application are, however, not so good as those given by hydrocarbon oils or DNC products. A premature application of FOLIDOL OIL SPRAY is, therefore, an uneconomical practice. This applies even more to the other oleo-phosphates. FOLIDOL OIL SPRAY is of great advantage for controlling San José scale because in contrast to the other oleo-phosphate insecticides, it is effective when applied at the normal concentration.

Like the winter sprays, the bud burst sprays should be applied at high rates, i.e. the wash must thoroughly wet all parts of the tree including the trunk. The extent to which it is actually necessary to wash in solutions of oleo-phosphate insecticides along the lines known for winter spraying, is a point that still has to be clarified.

For controlling cherry fruit moth, the bud burst sprays should be applied shortly before and up to the start of the bud swelling stage. It is advisable to add 300 gr. of green or blue copper. The combined application of an oleo-phosphate insecticide with 300 gr. of green or blue copper is recommended in all cases where it is planned to replace the pre-blossom spray application. This applies chiefly to fruit growing on farms and to smallholdings in general. The same spray treatment should be carried out on currants.

Bud burst sprays constitute a completely new group of products for controlling pests on fruit. These products especially satisfy the requirements of young orchardists who do not take kindly to the attacking and staining properties of winter sprays. No matter how pleasant the advantages of oleo-phosphate insecticides may be, is should not be forgotten, however, that bud burst sprays are phosphorus insecticides dissolved in oil, and moreover that their content of active ingredient is higher than that of summer sprays on the same basis. The presence of oil together with a phosphorus insecticide in a compound is proof that the winter sprays served as the prototype in the development of these products. The oleo-phosphate insecticides, however, are in reality something new. This fact must be observed by both advisory organisations and orchardists who frequently still connect these products with winter spraying, and bring about unnecessary failures because they apply the products at the wrong time.

The oil and the high content of active ingredient in bud burst sprays are necessary for obtaining an intensive effect. Therefore, just because the application of oleo-phosphorus insecticides is so pleasant as compared with winter sprays, the precautions specified for the handling of phosphorus insecticides should under no circumstances be disregarded when using oleo-phosphates. The bud burst sprays should be sprayed only at the specified concentration, and must not be atomized.

The scale on which oleo-phosphorus insecticides will also be used in commercial fruit growing, and whether they will in fact be able at all to replace winter sprays constitute questions which, as is so often the case, can be decided on only by growers themselves.

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The importance of winter sprays and the application of FOLIDOL®-OIL

by Heinz Sebbel, Orchardists' Advisory Organisation, Seestermühe

Pests that overwinter in the egg stage on fruit trees are usually controlled by carrying out a winter spray. The products primarily applied include hydrocarbon oils, dinitro-ortho-cresols or a combination of both products. The great advantage offered by applying a winter or post-winter spray on the bare wood is that it controls a large group of pests which may be dangerous to the young foliage and the bloom (winter moth, suckers, aphids etc.). On the other hand, other species whose control is just as important, are not checked — or if so then not adequately — by a winter spray (capsid bugs, lackeymoth, spider mites etc.). As there are also additional species that overwinter as larvae (summer fruit tortricid, bud moth etc.) and which cannot be sufficiently controlled by a winter spray, it is necessary to carry out a further insecticidal spray in the pre-blossom period despite the application of winter sprays.

It is, therefore, understandable that following the introduction of modern insecticides, the value of winter spraying soon came under discussion. In theory and in practice it is undisputed that all those pests which are eliminated by a winter spray can also be effectively controlled by a corresponding addition of insecticide to the pre-blossom sprays. Despite this situation, there are today still large areas where orchardists carry out winter spraying although there are also many regions where winter sprays are no longer applied.

The decision whether a winter spray is practical or not depends largely upon the prevailing weather in the respective area of cultivation. It is observed that winter spraying in commercial fruit farming is not carried out chiefly in those countries with a continental climate. In areas with a sea climate where the start of the spring season is delayed, pests that overwinter in the egg stage emerge over very long periods. Therefore, when the opportunity of controlling the entire egg population with one winter spray is allowed to pass, then several pre-blossom sprays will be necessary in order to kill the pests that emerge. Particular worry is caused here by aphids because they may take four weeks to emerge.

When growers wait until the last of the pests have hatched out, the first will already have inflicted too much damage; when the first pests that emerge are controlled, the remainder of the brood that follows may be so large that it might be necessary to carry out two more sprays.

Orchardists in regions with a sea climate cannot, therefore, afford not to avail themselves of the opportunity of at least eradicating the eggs of aphids with one winter spray. In many regions the concentration of winter spray products has been reduced to that level which is sufficient to give effective control of aphid eggs. Less susceptible pests which are not adequately controlled by this spray, are then killed by the application of insecticides in the pre-blossom period.

The dates of these pre-blossom sprays are not usually fixed according to the emergence of insect pests but rathermore according to the requirements

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for a preventive control of scab. By adding insecticide to the spray, all occurring pests are killed without any special costs being incurred through the application.

This situation changes as soon as aimed scab control is adopted and the spray is not carried out until after the germination of spores. In dry spring seasons, orchardists are very often faced by the fact that the occurrence of aphids, suckers, wintermoth etc. compels them to carry out one or perhaps even several special sprays because there is no cause to carry out a control of scab. With curative scab treatment, it is, therefore, of advantage to control insect pests occurring prior to the blossom period by applying a winter or post-winter spray that has a wide range of action. Consequently there will no longer be any need to carry out a pre-blossom spray in dry spring weather. This is an advantage that will be welcomed by all establishments because there are numerous working peaks in spring both for orchardists and farmers, and thus especially for those establishments which are not wholly engaged on fruit growing.

When the expediency of a winter or post-winter spray is considered from the aspect of a curative spray application against scab, then the advantage of eliminating promptly and extensively all pests that occur in the pre-blossom period is undisputed.

Unfortunately, however, it is not possible to attain a full effect with hydrocarbon oils and dinitro-ortho-cresols. The spray must be carried out in the dormant stage or before the buds swell so that we forgo the possibility of adequately controlling such pests as capsid bugs, bud moth, summer fruit tortricid etc. Our spray programme must, therefore, include the application of an insecticide in the pre-blossom period despite winter spraying, a disadvantage which in every case compels orchardists to carry out a pre-blossom spray. For this reason spray products which would make this additional work unnecessary are of interest to orchardists.

When the new spray FOLIDOL-OIL was placed at our disposal, we applied it from the following aspects:

1. Will this product give the same results as attained with those preparations so far used?
2. Are injuries to buds caused when the product is applied, as recommended, at bud swelling?
3. Is FOLIDOL-OIL so well tolerated by plants that it can also be applied in the advanced mouse-ear stage?
4. When FOLIDOL-OIL is applied so late, will it then be unnecessary to carry out a further pre-blossom insecticidal spray?

Test sprays were carried out at ten establishments, each on a plot of 1 hectare. 0.5 % FOLIDOL-OIL was compared with 4 % dinitrocarbolineum. This latter product was applied in the post-winter period during complete bud dormancy whereas FOLIDOL-OIL was sprayed at bud swelling or a little later. The purpose of this delayed application was to establish whether in this way a good kill is given also of those pests otherwise difficult to control. As this was not an exact test but rathermore involved an application of the product

under almost practical conditions, no O-plots were included. On the grounds of the observations made, the different questions raised above can be answered as follows:

1. In all comparison sprays, FOLIDOL-OIL proved just as effective as the dinitrocarbolineum applied. The plots were checked twice before the blossom but no differences were established.
2. No injuries were caused to buds.
3. When the treatment was carried out in the mouse-ear stage, no injuries were observed either on the small leaves or on the buds. The experience accumulated in spring 1958 indicates that the product is extremely compatible with plants. Therefore, a sufficiently large interval is left for spraying so that there will not be a working peak which cannot be overcome even if the spring weather is to set in suddenly.
4. Some of the plots sprayed with FOLIDOL-OIL were not given a further treatment with insecticides prior to the blossom. This had no apparent disadvantages. However, it cannot immediately be concluded from this that a guaranteed effect is given against those pests which in the past were difficult to control with a winter spray because experience has shown that several years must elapse before it can be established whether due to the change in the sequence of spray applications there will not be an over-reproduction of a pest that has so far been controlled.

Generally, it may be said that the spray operators found the handling of FOLIDOL-OIL to be a clean and pleasant process. This product does not cause yellow stains on the head and hands as is the case with dinitro-ortho-cresol, nor does it lead to skin burns such as are caused by carbolineum.

Summary

Winter spraying in regions with a sea climate is necessary in order to give effective and economical control of pests that overwinter in the egg stage, in particular aphids. When orchardists change over to the practice of curative scab control, then winter spraying gains importance.

FOLIDOL-OIL has the same range of action as those winter sprays so far used.

As FOLIDOL-OIL caused no injuries to the buds even when applied in the mouse-ear stage, there is every prospect that no further insecticidal sprays need be carried out before the blossom.

Studies on the efficiency of spraying and atomising in fruit farming in relation to distribution of wash, deposition of active ingredient and rain-resistance of deposits applied by spraying and atomising

by H. Goossen, Crop Protection Division of the Chamber of Agriculture, Westphalia/Lippe

1. Formulation of the problem

In view of the frequent treatments necessary in commercial fruit growing, it has become more urgent than ever to rationalize the use of crop protection equipment. To treat an orchard in the shortest possible time with only one operator means that the work must be done along fully mechanized lines. With the machinery available, this is possible for both spraying and atomising, the two most important methods of application in fruit farming. Regarding the performance and the biological efficiency of the methods, there is a difference of views, and important questions on this matter have still not been adequately settled (von Eickstedt, 1951; Schmid 1951; Scharmer, 1954; Scharmer and Singer, 1952; Thiem, 1953; Haronska, 1953 and 1954; Mauch, 1954 and 1957; Friedrich and Bauckmann, 1955). It therefore, appeared worthwhile to conduct studies with the object of comparing different methods and machines not only from the aspect of their economy but also especially with respect to their biological efficiency, thus contributing towards a clarification of questions still open. In these tests, the following machines were used in a commercial orchard situated in the Lübbecke district in Westphalia:

1. Self-propelled sprayer with lance
2. Self-propelled sprayer with spray gun
3. Self-propelled sprayer with curved boom
4. Tractor-drawn (trailer type) atomiser

In order to clarify causal relations between a possibly varying biological efficiency and the method of application, studies on the distribution of wash in the crop and quantitative determinations of active ingredient were carried out. Treatments with fungicides, insecticides and acaricides were extended over a whole vegetation period.

II. Method

To check the distribution of active ingredient, foils of paper were attached to leaves on the trees (Goossen 1952) as follows (per tree):

- 100 foils at a height of 250 cm
- 100 foils at a height of 200 cm
- 100 foils at a height of 150 cm
- 100 foils at a height of 100 cm
- 100 foils at a height of 50 cm.

* The author would express his thanks to Herr Bringewatt for allowing these tests to be carried out in his orchard, and for his very kind assistance and understanding.

The spray pattern exposure was replicated six times for both the inner side and the outer side of the trees, the inner side being that side of the tree facing the machine and the outer side that side of the tree away from the machine when the machine moves between two rows. The quantitative determinations of active ingredient were carried out according to the method of Neuhaus (1952) and Goossen and Eue (1954 and 1955); on the lower and upper surfaces of leaves at various heights (50, 100, 150, 200 and 250 centimetres above the ground); the results were recorded separately for the inner and outer sides of the trees.

The fungicides and insecticides were applied in plots containing the same varieties (Cox-Orange-Renette), and which were of adequate size thus precluding the possibility of influences from adjoining plots.

Sequence of treatments:

1st. treatment on April 2, 1957

- a) Spraying (1300 litres of solution/hectare)
 - Copper oxychloride at 0.4 %
 - DDT/lindane at 0.3 %
- b) Atomising (325 litres of solution/hectare)
 - Copper oxychloride at 1.6 %
 - DDT/lindane at 1.2 %
- c) Atomising (185 litres of solution/hectare)
 - Copper oxychloride at 2.8 %
 - DDT/lindane at 2.1 %

2nd. treatment on April 15, 1957

- a) Spraying (1300 litres of solution/hectare)
 - Wettable sulphur at 0.5 %
 - DDT/lindane at 0.05 %
- b) Atomising (325 litres of solution/hectare)
 - Wettable sulphur at 2 %
 - DDT/lindane at 0.2 %
- c) Atomising (185 litres of solution/hectare)
 - Wettable sulphur at 3.5 %
 - DDT/lindane at 0.35 %

3rd. treatment on May 2, 1957

- a) Spraying (1300 litres of solution/hectare)
 - Captan at 0.25 %
- b) Atomising (325 litres of solution/hectare)
 - Captan at 1 %
- c) Atomising (185 litres of solution/hectare)
 - Captan at 1.75 %

4th. treatment on May 22, 1957

- a) Spraying (1300 litres of solution/hectare)
 - Captan at 0.25 %
 - Parathion at 0.035 %
- b) Atomising (325 litres of solution/hectare)
 - Captan at 1 %
 - Parathion at 0.14 %

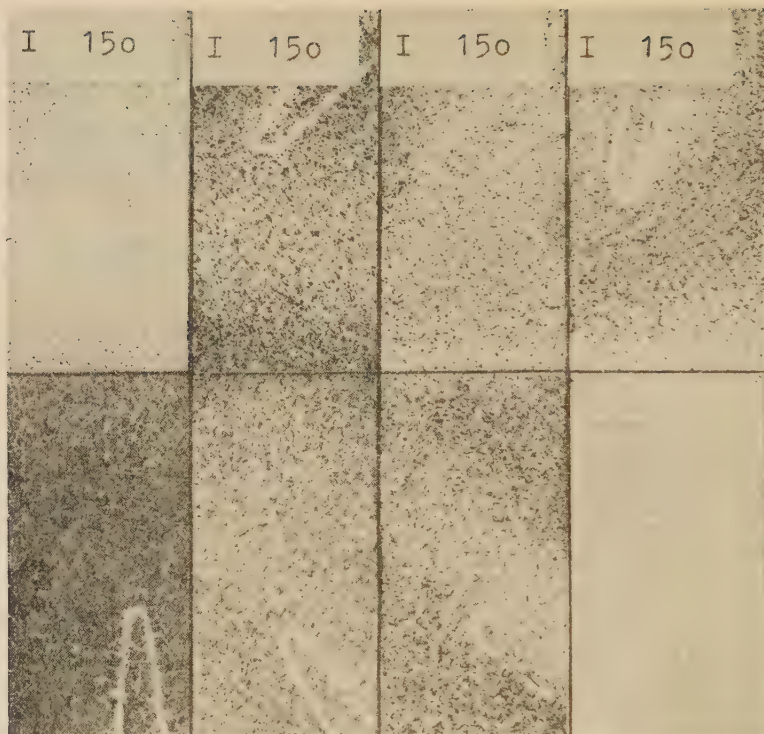


Fig. 1: Section of spray pattern obtained in application with a self-propelled motor-powered sprayer fitted with curved boom. The spray pattern was prepared on that side of the tree facing the sprayer, at a height of 150 cm above the ground. Top halves of sprayed paper strip represents upper leaf surfaces, bottom halves are the lower leaf surfaces

- c) Atomising (185 litres of solution/hectare)
- | | |
|-----------|------------|
| Captan | at 1.75 % |
| Parathion | at 0.245 % |

5th. treatment on June 5, 1957

- a) Spraying (1300 litres of solution/hectare)
- | | |
|-------------|-----------|
| Captan | at 0.25 % |
| METASYSTOX® | at 0.1 % |
- b) Atomising (325 litres of solution/hectare)
- | | |
|------------|----------|
| Captan | at 1 % |
| METASYSTOX | at 0.4 % |
- c) Atomising (185 litres of solution/hectare)
- | | |
|------------|-----------|
| Captan | at 1.75 % |
| METASYSTOX | at 0.7 % |

® = Registered trade mark of Farbenfabriken Bayer Aktiengesellschaft, Leverkusen

6th. treatment on June 19, 1957

- a) Spraying (1300 litres of solution/hectare)
 - Captan at 0.25 %
 - Lead arsenate at 0.4 %
- b) Atomising (325 litres of solution/hectare)
 - Captan at 1 %
 - Lead arsenate at 1.6 %
- c) Atomising (185 litres of solution/hectare)
 - Captan at 1.75 %
 - Lead arsenate at 2.8 %

7th. treatment on July 3, 1957

- a) Spraying (1300 litres of solution/hectare)
 - Captan at 0.25 %
 - Lead arsenate at 0.4 %
 - METASYSTOX at 0.1 %

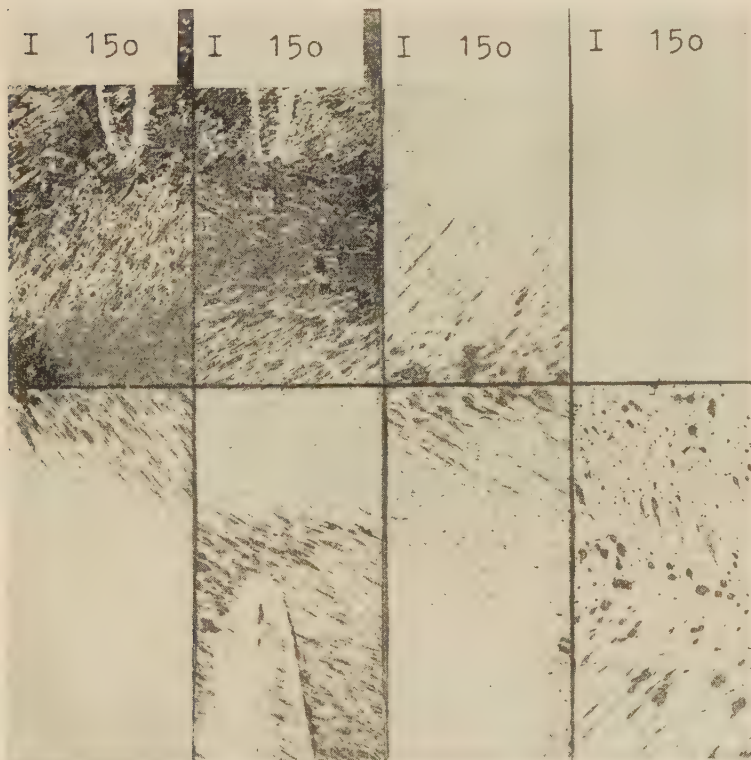


Fig. 2: Section of spray pattern obtained in application with a self-propelled motor-powered sprayer equipped with a spray gun. Other details as for Fig. 1

b) Atomising (325 litres of solution/hectare)

Captan at 1.0 %

Lead arsenate at 1.6 %

METASYSTOX at 0.4 %

c) Atomising (185 litres of solution/hectare)

Captan at 1.75 %

Lead arsenate at 2.80 %

METASYSTOX at 0.7 %

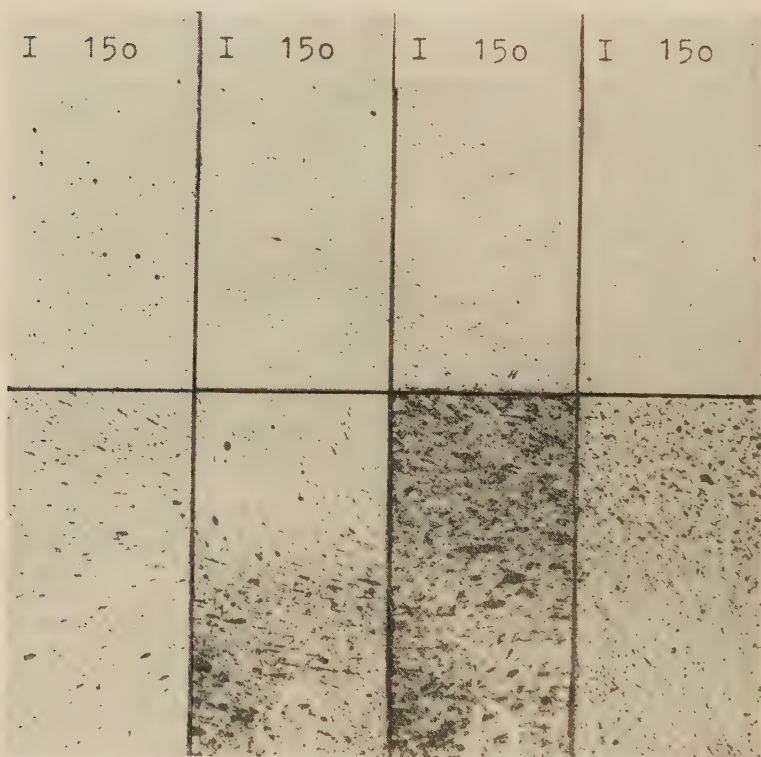


Fig. 3: Section of spray pattern obtained with a plantation atomiser (rate of application: 325 litres of solution/ha). Other details as for Fig. 1

8th. treatment on July 14, 1957

Due to persist bad weather, it was not possible to carry out an experimental treatment. However, in order to counter the danger of scab infection during the critical period of fusicladium incidence, all plots with the exception of the untreated check were atomised, despite the unsettled weather, at a rate of 325 litres of fungicide (Captan) per hectare.

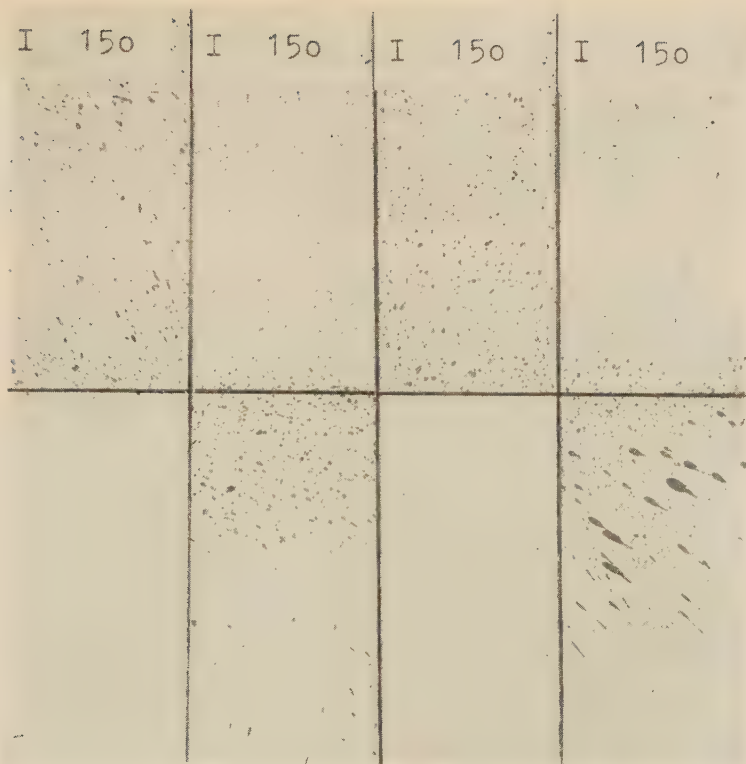


Fig. 4: Section of spray pattern obtained with a plantation atomiser (rate of application: 185 litres of solution/ha). Other details as for Fig. 1

9th. treatment on August 1, 1957

- a) Spraying (1300 litres of solution/hectare)
TMTD at 0.125 %
- b) Atomising (325 litres of solution/hectare)
TMTD at 0.5 %
- c) Atomising (185 litres of solution/hectare)
TMTD at 0.875 %

III. Results

a) Distribution of wash and quantitative determination of active ingredient

The varying distribution of wash, depending upon the method of application, is evident from Figs. 1 to 8. Spraying at a rate of 1300 litres of solution per hectare gives a higher degree of coverage than atomising.

Spraying was superior to the atomising method especially with respect to treating both sides of the leaves. This form of treatment applies only in those cases where the lower and upper surfaces of the same leaf were treated. In atomising practices, however, it happens more frequently than in spraying applications that only the upper surface or only the lower surface of the leaf is wetted at high rates of application. When spray guns are used, the active ingredient is distributed in larger droplets than when applied with curved booms and atomisers. For all methods of application, however, deposition

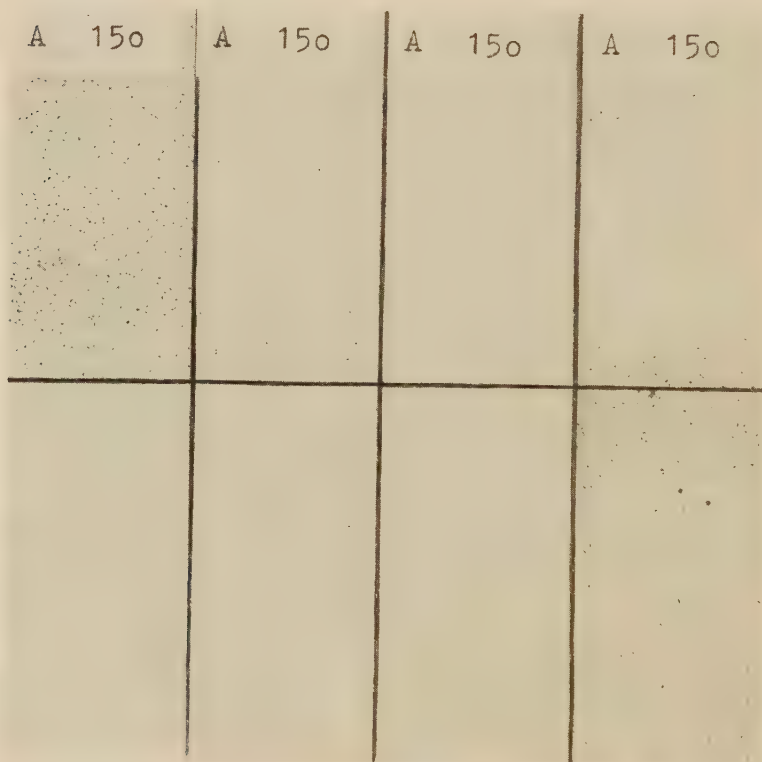


Fig. 5: Section of spray pattern obtained as in Fig. 1, except that it was prepared on that side of the tree away from the sprayer

varies at the different heights (Figs. 10 to 13). This condition of nonuniformity was observed for practical usage of the machines even though a spray pattern prepared on a paper strip (Fig. 9) before the start of the tests showed that the distribution of droplets was even at all heights. The spray patterns prepared in the tree stand revealed that treatment of rows of trees from one side only is not adequate, this applying to both spraying and atomising.

To obtain an even coverage of wash on all sides, it is absolutely necessary for machines operating from both sides to be driven through each row. Regarding the penetration of foliage in a row of trees, spraying by means of a spray gun is superior to the other methods. When the spray gun is compared with the curved boom using the same volumes of solution, it is evident that the spray gun gives a high degree of coverage on the outer side of the tree although it is also necessary with spray guns to spray both sides row for row if the active ingredient is to be evenly deposited in the tree stand. It is not recommended to apply the solution across several rows in fruit plantations.

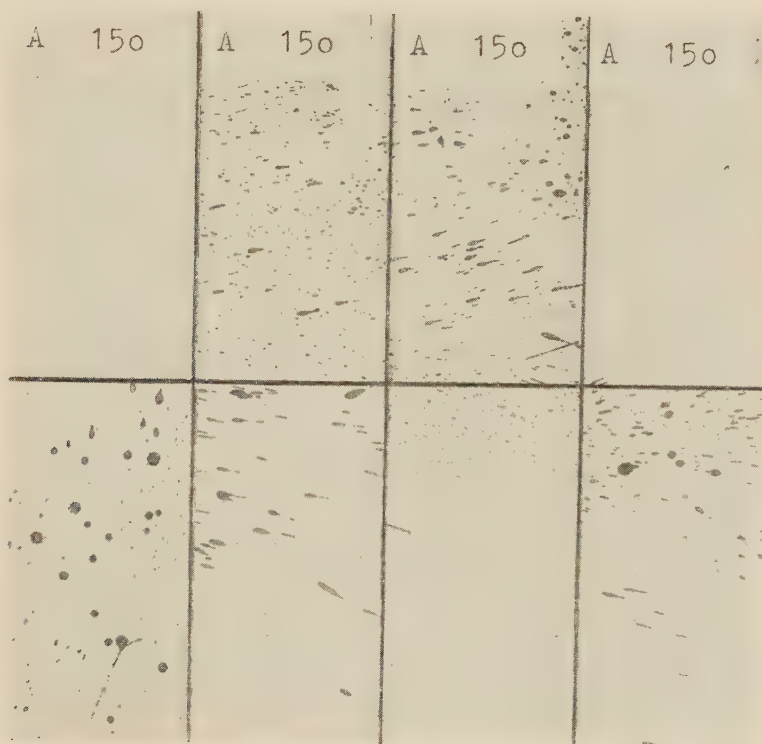


Fig. 6: Section of spray pattern obtained as in Fig. 2, but on that side of the tree away from the sprayer

As the spray patterns prepared for determining the distribution of wash and droplets do not provide an indication of the quantity of active ingredient deposited on the leaves, colorimetric Cu-determinations were also carried out. A comparison of the absolute quantities of active ingredient measured on the leaves for different machines and methods of application is given in Fig. 14. The largest quantity of active ingredient was deposited in the spraying method,

the next largest in the atomising method 1:4 and the smallest quantity in the atomising method 1:7. This result applies to both the outer side and the near side of the trees. Following rainfall, the losses of active ingredient brought about by the deposits being washed off, are greater in sprayed plots than in those plots treated by atomising so that with respect to residual quantities of active ingredient the atomising method was superior or at least equal to spraying (Fig. 15). A comparison of the quantities of active ingredient deposited

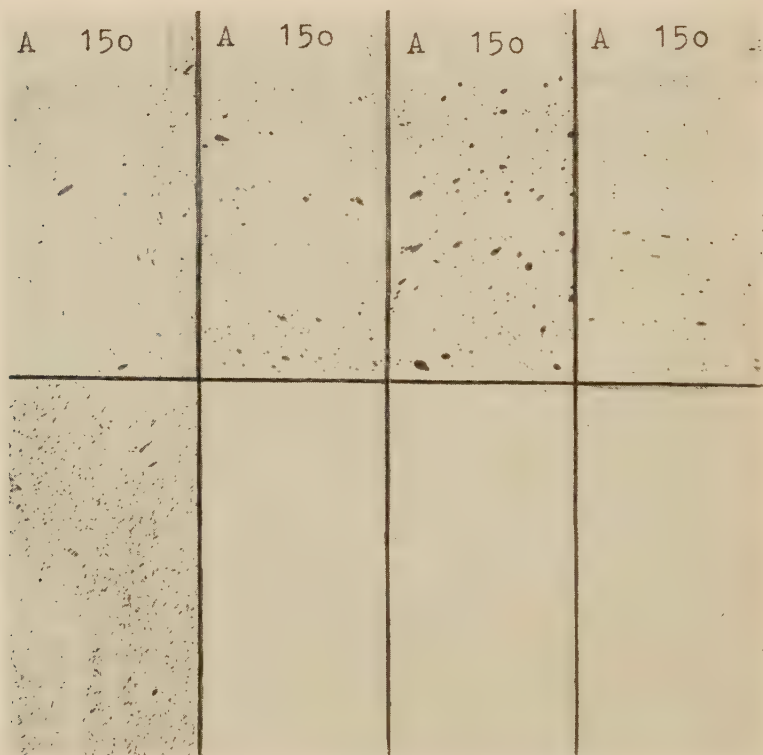


Fig. 7: Section of spray pattern obtained as in Fig. 3, but on that side of the tree away from the atomiser

on the upper and lower surfaces of the leaves showed that approximately the same quantities of active ingredient are deposited on both sides of the leaves (Fig. 16). The spray patterns prepared in the tree stand showed that these numerically parallel results do not necessarily have to be evaluated equally for spraying and atomising. Whereas the leaves were wetted on both sides to a greater degree following applications with spraying equipment, the values determined for the lower and upper leaf surfaces following atomising are to be

attributed to the fact that approximately 50 % of the leaves had most of the applied active ingredient deposited on the upper surface whereas approximately 50 % received far greater coverage on the lower surface, in other words the leaves were treated only on one side, either the upper or the lower surface. Following rainfall the ratio of active ingredient changes in favour of the lower surface of the leaves because this surface is less exposed to raindrops than the upper surface (Fig. 17).



Fig. 8: Section of spray pattern obtained as in Fig. 4, but on that side of the tree away from the atomiser

The determinations of active ingredient quantities also confirm the results of the spray pattern tests, namely that

1. the distribution of active ingredient is not even over the entire height of the tree (Fig.16) and
2. a one-sided treatment of trees is not sufficient either for applications by spraying or for treatments by atomising.

b) Biological effect

The evaluations included the following insect pests and diseases:

1. Apple blossom weevil
2. Spider mite
3. Winter moth
4. Ermine moth
5. Aphid
6. Codling moth
7. Scab

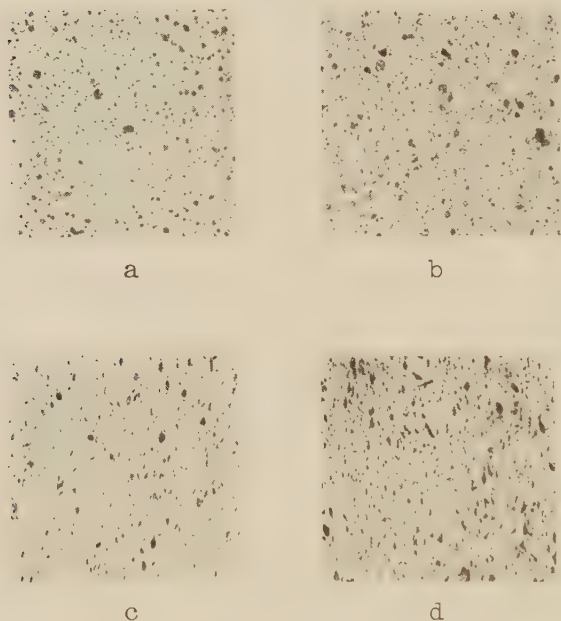


Fig. 9: Section of spray pattern obtained with the plantation atomiser at heights of 100 (a), 150 (b), 200 (c) and 250 cm (d) on a continuous paper strip stretched out at a distance of about 1 metre to the side of and 2–3 metres above the atomiser head of the machine

The results of the evaluations are compiled in Table 1. The biological effects were good in all treated plots, although they differed. Atomising at a rate of 185 litres of solution per hectare generally gave a somewhat weaker effect than spraying and atomising at a rate of 325 litres per hectare (1:4). A comparison of atomising (325 litres per hectare) and spraying shows that the atomising method holds slight advantages in the control of insect pests. Scab spots were not observed in the evaluation of the sprayed plots, and in the

atomised plots there were only slight symptoms. Scab cracks (Fig. 18) (scab spots and cracks are combined in Table 1) were not so prevalent in the sprayed plots as in the atomised plots. 1957 was not a marked scab year in Westphalia/Lippe. It is to be assumed that the slight differences in the treated plots which were established in the tests, are more evident and more influential in years when the prevailing weather conditions are favourable to inci-

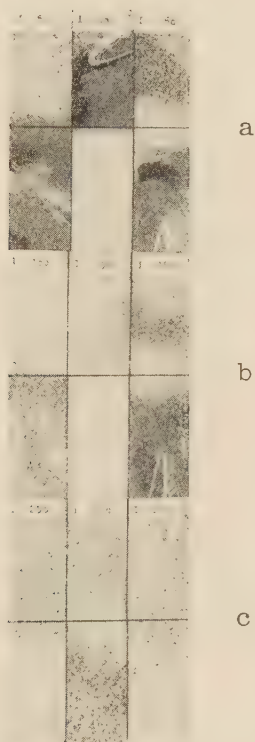


Fig. 10: Sections of spray pattern for a curved boom at heights of 50 (a), 150 (b) and 250 cm (c) above the ground. Top halves of paper strip represent upper surfaces of apple leaves, bottom halves are lower surfaces. Spray pattern prepared on side of tree facing the machine

dence of fusicladium. The evaluation of the yield which included the total crop, the number of apples per tree and a size grading, produced the results compiled in Table 2. The yield per tree in the treated plots was almost twice as big as in the untreated checks. The number of apples per tree was larger in the treated plots, and moreover a size grading showed that the apple sizes were more uniform in the sprayed and atomised plots. The percentages of

Table 1: Most important results of evaluation

No.	Method of application	Rate of application in litres of solution per hectare	Apple blossom weevil		Winter moth		Ermine moth		Apple aphid		Spider mite		Codling moth		Scab	
			Check on 16. 5. 57 blossoms in %/o	16. 5. 57 blossoms in %/o	Check on 16. 5. 57 shoots attacked	16. 5. 57 shoots in %/o	Check on 2. 7. 57 no. of colonized webs per tree	16. 5. 57 no. of colonized webs per tree	Check on 16. 5. 57 shoots colonized by aphids in %/o	16. 5. 57 no. of mites per 10 sq. cm. of leaf area	25. 7. and 9. 8. 57 no. of mites per tree	25. 7. and 9. 8. 57 no. of mites per tree	25. 7. and 9. 8. 57 no. of mites per tree	25. 7. and 9. 8. 57 no. of mites per tree	25. 7. and 9. 8. 57 no. of mites per tree	25. 7. and 9. 8. 57 no. of mites per tree
1	Untreated	—	27	40	35	40	17	29.5	22.9	261	20.2	261	20.2	261	20.2	261
2	Spraying	1300	6	10	0	0	6	3.0	0.3	40	4.5	40	4.5	40	4.5	40
3	Atomising	325	4	0	0	0	3	1.0	0.1	71	7.4	71	7.4	71	7.4	71
4	Atomising	185	12	20	0	0	9	2.5	0.3	82	8.7	82	8.7	82	8.7	82
5	Atomising	325	3	10	—	0	6	—	—	—	—	—	—	—	—	—
6	Spraying	1300	5	0	—	0	0.8	—	—	—	—	—	—	—	—	—
7	Spraying	1300	0	0	—	5	2	—	—	—	—	—	—	—	—	—
8	Spraying	1300	1	10	—	0	0.1	3.0	0.4	—	—	—	—	—	—	—
9	Atomising	325	1	0	—	0	0.2	0.2	0.02	—	—	—	—	—	—	—



Fig. 11:
Sections of spray pattern for spray gun. Other details as for Fig. 10

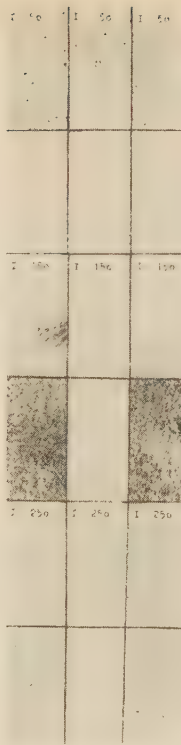


Fig. 12:
Sections of spray pattern for plantation atomiser (rate of application: 325 litres of solution per hectare). Other details as for Fig. 10



Fig. 13:
Sections of spray pattern for plantation atomiser (rate of application: 185 litres of solution per hectare). Other details as for Fig. 10

medium and especially marketable size classes (4, 5 and 6), in proportion to the total yield, were as follows:

- 88.5 % for spraying (1300 litres per hectare)
- 90.3 % for atomising (325 litres per hectare)
- 83.5 % for atomising (185 litres per hectare)

In the untreated checks, on the other hand, the comparative value amounted to only 76.4% of the apples picked. A striking feature was the difference in the colouring of Cox-Orange-Renette in the treated and untreated plots (Fig. 19).

IV. Discussion of results

From the studies on distribution of wash and deposition of active ingredient, it may be concluded that as a rule atomising gives a more even coverage of active ingredient than spraying, although the actual quantity of active ingredient deposited on the plants is greater for spraying than for atomising.

Due to the higher percentage of small droplets of solution in the mist produced by atomising, there is a greater danger of drift and suspension in air of droplets of liquid (Wöllmer, 1951, Gossen, 1957). Despite a high blower output of the atomiser used, these processes favoured by horizontal and verti-

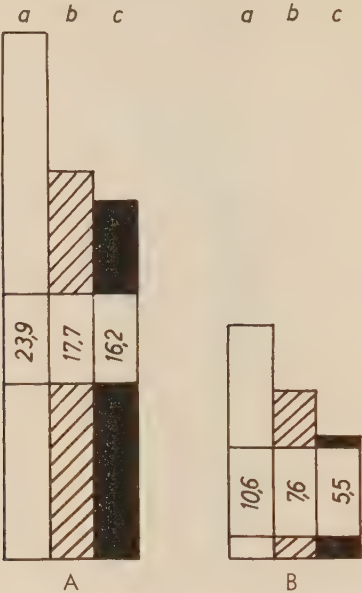


Fig. 14: Absolute quantities of active ingredient before rainfall, which were established on the leaves by means of colorimetric copper determinations. a = spray gun, b = plantation atomiser (325 l/ha), c = plantation atomiser (185 l/ha). A = near (inner) side of tree, B = outer (facing away) side of tree. These are Cu values determined from the addition of 100 values obtained at the different heights of 50, 100, 150, 200 and 250 cm for lower and upper leaf surfaces

Table 2: Results of yield evaluation

No.	Method of treatment	Rate of application l/ha	Total no. of sorted and evaluated apples (no. of trees in brackets)	Relative yield in % (untreat.=100)
1	Untreated	—	1291 (27)	100
2	Spraying	1300	941 (10)	186
3	Atomising	325	963 (10)	186
4	Atomising	185	878 (10)	194

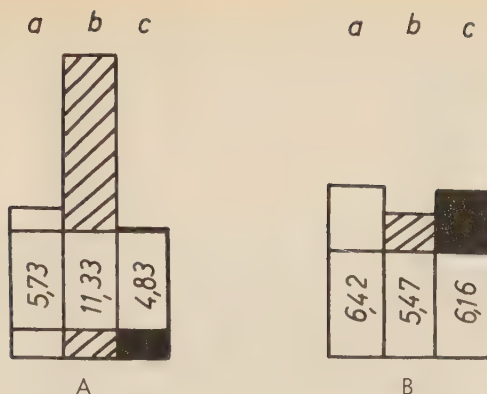


Fig. 15: Absolute quantities of active ingredient after rainfall. (Amount of rainfall = 101.3 mm.)
Other details as for Fig. 14

cal wind currents could not be sufficiently prevented. The losses of small and minute droplets of solution brought about due to drift and suspension in air are all the greater the longer the distance over which the droplets of active ingredient have to be carried. The amount of active ingredient actually lost in travel to the leaves on the top third-section of the tree is clearly reflected in the Cu-values which were obtained while determining the active ingredient values on the upper part of the tree (Fig. 16). Machine designers and field workers should, therefore, not select too small a droplet size for atomisers, but should produce and use droplets of not under 150 microns despite saving of solution. In other words, "spraying with a carrier air current" is to be recommended according to the definition for droplet size valid in Germany. In order to obtain deposition of active ingredient in the top parts of the tree in the same quantity as in the middle-parts, it is recommended not to distribute the air produced by the fan evenly over the entire spraying or atomising sector

No. of apples per tree	Size grading in %							
	1 45 mm	2 50 mm	3 55 mm	4 60 mm	5 65 mm	6 70 mm	8 75 mm	8 80 mm
47.8	0.8	2.0	6.2	19.0	30.0	27.4	11.5	3.1
94.1	0.1	0.1	3.9	23.9	40.9	23.7	5.9	1.5
96.3	0	0.1	5.3	28.0	41.1	21.2	2.3	2.0
87.8	0.1	0.1	1.7	11.0	35.8	36.7	12.1	2.5

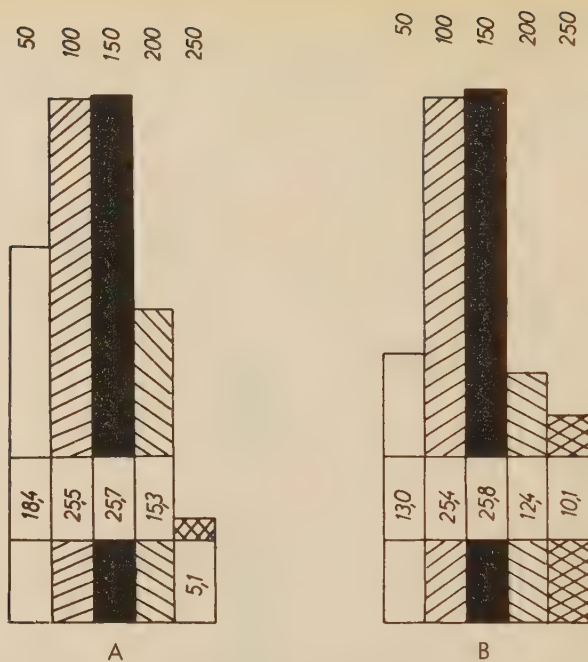


Fig. 16: Absolute quantities of active ingredient on the upper leaf surfaces (A) and lower leaf surfaces (B) before rainfall at different heights above the ground (50, 100, 150, 200 and 250 cm). Applied by means of the orchard atomiser

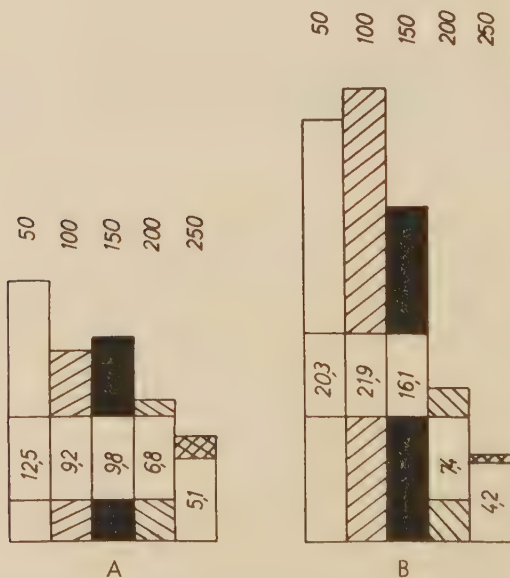


Fig. 17: Absolute quantities of active ingredient on the upper and lower leaf surfaces after rainfall, (Amount of rainfall = 101.3 mm.)

but to use a larger quantity of air in the upper section, as is sometimes the case with machines operating from only one side (Fig. 20) to give a better deposition of liquid droplets also for long carry. It is of the utmost importance that the active ingredient should be deposited also in the upper parts of the tree because



Fig. 18: Cracks on apple (photo by Crop Protection Division, Münster)

1. scab infection often begins on top shoots of the tree which have been inadequately treated, and is then spread rapidly by rain over the whole tree, and
2. active ingredient is washed by rain from the top to the bottom parts of the tree, and not vice-versa, as corresponding determinations of active ingredient have shown.

Following rainfall, the quantity of active ingredient present on foliage close to the ground is relatively large, and relatively small towards the top of the tree. The ratio of active ingredient on the lower leaf surfaces does not undergo such considerable change either before or after rainfall (Fig. 17).

The differences in deposition of active ingredient and distribution of solution which were most evident for the various methods of treatment, were less marked for the biological effect. In view of the experience accumulated, the fully automatic atomising technique and the spraying practice using curved

booms and lances can be recommended to orchardists as more or less equally effective techniques. Atomising involving small droplets is far more dependent upon wind conditions than spraying. An effect equal to that given by spraying can only be expected when operators can postpone the treatment until favourable weather conditions prevail (slight horizontal and vertical wind). In the tests referred to in this paper, the treatments were mostly carried out in the mornings and evenings when there was little wind. A temporal limitation in



Fig. 19: Cox-Orange-Renettes from untreated (left) and treated plots (right) (photo by Crop Protection Division, Münster)

dependence upon wind conditions is not always permissible due to the danger of scab infections. In order to make applications less dependent upon wind conditions, it is advisable also when atomising to use droplets which are of approximately the same size as those produced by spraying techniques. To avoid formation of a deposit of active ingredient that is full of gaps when large droplets are applied, it is necessary to reduce the rate of application at the most to a ratio of 1:4 as compared with the normal rate. In the tests that were carried out, it was established that a reduction of the amount of solution to 1:7 made the effect uncertain, and that this would have been even more pronounced if the treatments had been carried out over a longer period. It might have been expected in 1957 that 7 or 8 treatments by spraying at 1300 litres per hectare and atomising at 325 litres per hectare would give a full effect yet the treatment in which 185 litres of solution were applied per hectare

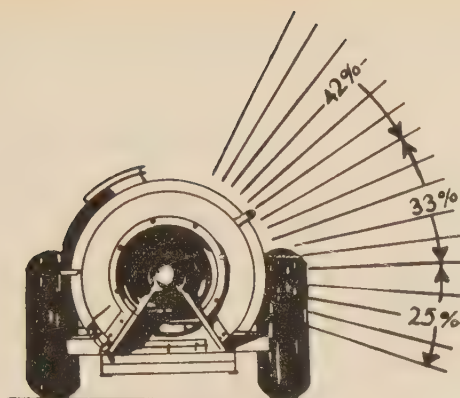


Fig. 20: Distribution of the air blast in the different spray sections for an atomiser operating from one side

by atomising indicates that to obtain satisfactory results in the case in question (1957), nine applications were necessary. The fact that satisfactory results were obtained despite the smaller quantities of active ingredient actually deposited on the plants by atomising, is to be attributed to the better resistance to rain of the atomising coatings. The slighter degree of washing-off by rain for products applied by the atomising technique until the next treatment resulted in a total quantity of active ingredient following each new application (residual quantity from the preceding application + active ingredient deposited in the new treatment); this quantity is estimated at being approximately the same for

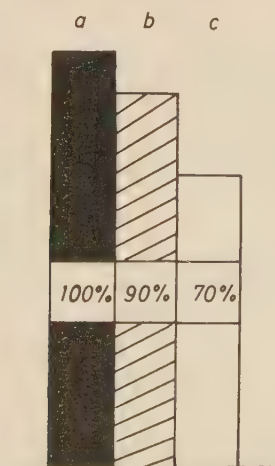


Fig. 21: Total quantities of active ingredient for spraying at 1300 l/ha (a), atomising at 325 l/ha (b) and atomising at 185 l/ha (c), obtained by adding the values for residual quantities from the preceding application and quantities of active ingredient deposited in the new treatment

spraying and for atomising at a rate of 325 litres per hectare. On the other hand, there are very perceptible differences between the above practices and atomising at a rate of only 185 litres of solution per hectare (Fig. 21).

V. Summary of the most important results

1. Applying the same quantities of active ingredient, the spraying technique gave a greater deposition of active ingredient on the treated plants than the atomising method.
2. A reduction of the rate of application for atomising to 185 litres of solution per hectare (1:7) resulted in appreciably less active ingredient being deposited than for atomising at a rate of 325 litres per hectare (1:4).
3. Application of wash by means of a curved boom produced a more favourable coverage effect than application with a spray gun. The reason for this is attributed to the relatively large droplets of solution applied with the spray gun.
4. Deposits applied by atomising were more resistant to rain than sprayed deposits. As a result, the total quantities of active ingredient following each replicated treatment, which were determined on the tree, were approximately the same for spraying and atomising.
5. The foliage growing above a height of 200 centimetres was covered with relatively little active ingredient in the tests carried out, irrespective of whether the products were sprayed or atomised, this despite the fact that the machines were set in such a way that even coverage ought to have been given. When the wash is applied on an object a relatively large distance away from the nozzle, a high percentage of small and minute droplets are carried away by horizontal and vertical currents of wind.
6. It is recommended when atomising over relatively large distances to distribute the carrier air current accordingly in order to eliminate the appreciable loss of active ingredient.
7. A reduction of the droplet sizes to less than 150 microns is regarded as a dangerous practice also for atomising.
8. There are only slight differences between fully mechanical spraying at 1300 litres per hectare and atomising at 325 litres per hectare with respect to the biological effect so that both methods of application can be recommended to orchardists.
9. A reduction of the rate of application in the atomising technique to one-seventh of the normal rates (185 l/ha) does not appear advisable also for reason of the biological effect, and this practice can only be recommended in cases where it is absolutely necessary.

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Practical Method for Controlling Cabbage Maggots with “E 605®”

by Olaf Nielsen, Lyngby, Denmark.

As every cabbage grower knows only too well, cabbage maggots cause severe damage to crops. These pests must, therefore, be controlled at all costs in all places where Brassica species, in particular cauliflower, are cultivated at a time when cabbage maggots occur.

Controls are carried out by treating the plants with different insecticides by means of the soil watering technique; of these insecticides, E 605 has proved in Denmark to be the least expensive and at the same time the most effective product. We work with a 0.05 % dilution of the E 605 commercial product* applied at a rate of approximately 100 ccs per plant.

The treatment of cabbage plants by the soil watering technique is a practice that takes up considerable time when large acreages are involved. For this reason, a Danish market gardener has devised a method whereby this work can be carried out practically, easily and quickly. The details of this method are outlined below.

A barrel with a capacity of 200 litres is mounted on the tractor; a pipe runs from the bottom of the barrel to a transverse distributing boom which is fitted with four welded-on adapters (Photo 1). Four hoses are secured to these adapters (Photo 2).

Each hose is fastened to a bamboo rod which holds and guides the hose when treating the plants (Photo 3). The hoses and the rods are suspended from hooks fixed on the top edge of the barrel. When the operators are ready to start “watering” the plants, the rods are taken down from the hooks (Photo 4) and held over the rows of plants; they are moved forwards intermittently so that the bulk of the solution is applied directly on the plants. It is not necessary to fit the hoses with a tap to stop the flow of solution when the hose is guided from one plant to the next. With a little practice this can in fact be

* 35 % active ingredient content (diethyl-p-nitrophenyl ester).

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Photo 1

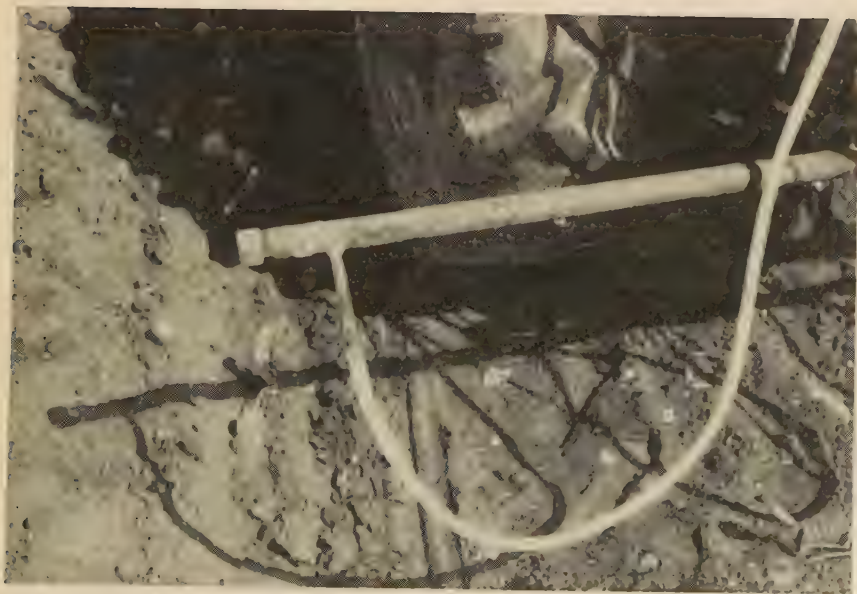


Photo 2



Photo 3



Photo 1



Photo 5



Photo 6



Photo 7

done without much solution being wasted between the plants (Photo 5, 6 and 7). In this way, four rows can be treated at the same time while the tractor moves forward in first gear. When the treatment has been completed or work is broken off temporarily, the hoses need only be held upwards on the rods and then suspended from the hooks at the top of the barrel.

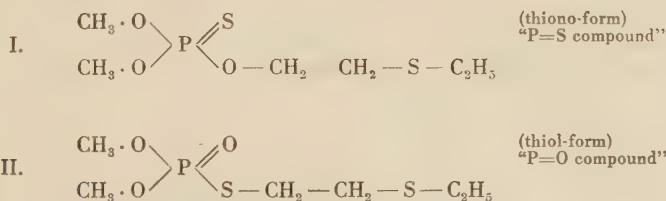
By means of this method, 60,000 plants can be treated in the field quite easily in one eight-hour working day.

Toxicological studies on the practical application of the systemic insecticide 0,0-dimethyl-(ethyl-thioethyl)-thiophosphate

by O. R. Klimmer and W. Pfaff

The development of modern insecticides of the organic phosphate group, which act as stomach, breathing and contact poisons, led via 0,0-diethylthionophosphoric acid-O-paranitrophenyl ester (E 605[®] *) and other products to the discovery of systemic insecticides, substances that feature quite a different mechanism of action on the plant. When they are applied to the leaf or root systems of a living plant, these substances are absorbed into the sap stream and translocated, rendering the plant insecticidal to sucking and biting insects until the substances are finally broken down. This range of compounds includes octamethyl pyrophosphoramidate (Ompa[®], Pestox III[®], Schradan[®]), the more effective 0,0-diethyl-(ethyl-thioethyl)-thiophosphate (SYSTOX[®] *) and finally the compound 0,0-dimethyl-(ethyl-thioethyl)-thiophosphate (METASYSTOX[®] *), all of which have been developed by G. Schrader (1, 2).

As we established in previous toxicological investigations (23) on small laboratory animals, dogs and persons who volunteered for testing, METASYSTOX by virtue of its lower order of acute toxicity and its lower vapour pressure is far less hazardous in practical application than SYSTOX. As a result, METASYSTOX has largely replaced SYSTOX in crop protection. Like SYSTOX, METASYSTOX also has 2 isomeres, the thiono- and the thiol-compound:



The P=S compounds of SYSTOX and METASYSTOX may to a certain degree change into the more toxic P=O compound, whereby this process of isomerization increases proportional to the rise in temperature and is catalytically accelerated by polar solvents (3).

A number of papers (4—20) have been published dealing with the pharmacological-toxicological effects of SYSTOX on warm-blooded animals and human beings, this product's phenomena of isomerism and their quantitative

* [®] = Registered trade mark of Farbenfabriken Bayer Aktiengesellschaft, Leverkusen

determination. The more recent insecticide METASYSTOX, on the other hand, has been considerably less investigated (21—28). As this product attaches great practical importance, especially in Germany, as an insecticide used to control leaf-sucking pests, and in view of the fact that questions appertaining to the exposure to hazards of operators employing different methods of application, and to the protection of the body and respiration, are of major interest from the aspect of industrial toxicology, we conducted in Autumn 1956 and in Summer 1957 — in cooperation with the Federal Biological Institute for Agriculture and Forestry, Braunschweig, the Crop Protection Office, Bonn, the Horticultural Research Station, Friesdorf-Bad Godesberg, and the Nord-westdeutsche Kraftwerks-A.G., Wiesmoor/Ostfriesland — a series of analytical and toxicological studies in the field and in greenhouses with METASYSTOX on voluntary test persons and on test animals. We would express our thanks to the various departments of Farbenfabriken Bayer A.G. at Leverkusen and Wuppertal-Elberfeld for the most generous assistance they rendered us in our work.

I. Analytical tests in the field (Friesdorf)

When the active substance of a crop protection product is applied, its concentration in the air also depends on the application technique; therefore, in determining the concentration of METASYSTOX, we used in all tests the two most important methods for applying this product. Firstly we investigated the older spraying practice in which 0.1 % aqueous solutions of METASYSTOX (0.05 % active substance) were applied by means of a knapsack type, hand-operated sprayer and a mobile motor-powered sprayer, using relatively large volumes of water. The droplet size and the throw of the spray jet were governed by the applied pressure and the nozzle diameter which in our tests conformed to standard values and were kept constant. In the comparison tests the more recent low volume atomizing method was adopted; here, smaller volumes of a ten times stronger solution of METASYSTOX (0.5 % active substance) are applied. This is done by atomizing with two-component nozzles; an aerosol is produced in the portable or mobile motor-powered apparatus used, which is blasted through the outlet aimed by the operator. The technical advantages of this method are that water cartage is reduced considerably and fewer working hours are needed to complete the operation. In low-volume atomizing, aerosols of large droplets are purposely applied; these do not volatilize so quickly, are deposited more evenly giving uniform coverage, have a better adhesion property on the plants, and guarantee smaller loss of active substance. In these tests, too, the machines, operating pressure and air velocities used conformed to standard specifications; the tests were carried out under our supervision by crop protection technicians in a harvested orchard containing 3—4 metre high spindle trees.

The commercial product METASYSTOX contains 50 parts of emulsifier and 50 parts of an active substance mixture; this latter is made up of approximately 30 % P=O compound and 70 % P=S compound. Due to the aforementioned phenomenon of isomerization, the 70:30 % ratio of the isomere mixture changes in favour of the P=O compound. Furthermore a change is also

brought about in the volatility of the active substance mixture, this being 23.3 mg/m³ air at 20°C for the P=S form, and only 5.7 mg/m³ air for the P=O form. In order to preclude all instability factors and to obtain the highest possible concentrations of active substance in the air, we used only the more volatile P=S form of METASYSTOX in this analytical test series. Further, to avoid all analytical difficulties, Dr. G. Schrader, head of the crop protection laboratory of Farbenfabriken Bayer Aktiengesellschaft, Elberfeld, had this compound prepared for us labelled with radioactive phosphorus (P³²).

The rates of application per hectare and tree and the application technique conformed in all tests to conventional field practice. The sprayer operator and assistants wore protective rubber clothing and respirators fitted with combined

Table 1:

Test No.	Method	Sprayer type	Duration of application	Quantity of solution consumed total	per min. l	Active substance conc.
I.	Spraying	"Holder" type knapsack sprayer, 10 atm. gauge	15	30	2	0.05
II.	Low volume atomizing	"Solo" type knapsack atomizer powered by "Ilo" type motor	9	9	1	0.5
III.	Spraying	"Fricke" type motor-powered three-piston sprayer mounted on "Unimog" type truck	25	170	6.8	0.05
IV.	Atomizing	"Solo-Rex" type mobile motor-powered atomizer, 8 atomizer heads	5	45	9	0.5

suspended material-carbon filter element. While the spraying team was at work, a free analytical filter was held by an assistant at mouth height just in front of the sprayer operator. A precisely dosed quantity of air was sucked through this filter by means of a hose, gas meter and electric vacuum pump (mounted on a mobile base). As the conditions during the forward movement of the working group among the trees varied continually due to the unavoidable change of working direction, the size and shape of the treated objects, rebound of particles and wind direction, determinations had to be carried out in each test at different points in the working area. Due to the density of the trees and the resultant technical difficulties, these determinations had to be limited to 2—3 carried out in the immediate vicinity of the sprayer operator.

The radioactivity in the carbon and suspended material parts of the filter elements was determined separately in several counts carried out at the crop protection laboratory of Farbenfabriken Bayer Aktiengesellschaft, Elberfeld, and the quantity of gaseous and suspended material-form METASYSTOX was calculated from the maximum values obtained. From this and also on the basis of the quantity of air, it was possible to calculate the METASYSTOX concentration in mg per cubic metre of air. The relative humidity and temperature which amounted to 85—100 % and 11—16° C, respectively, were registered graphically; the wind velocity was recorded at 1—2 metres/sec. Table 1 gives

Table 2:

Test No.	Filter No.	Air vol. in l	Quantity of METASYSTOX found (expressed in γ) in				Calc. conc. mg METASYSTOX m ³ air	Type of Filter
			Suspend. material part	Carbon part	Total quantity	Ratio 4 : 5		
1	2	3	4	5	6	7	8	9
I.	1	185 +	138	119	257	1:16 : 1	1.4	Free analyt. filter Assistant Sprayer operator
	2	200 + +	19	140	159	1 : 7.3	0.8	
	3	200 + +	45	80	125	1 : 1.8	0.62	
II.	4	153 +	450	89	539	5 : 1	3.5	Free analyt. filter Assistant Sprayer operator
	8	120 + +	50	183	243	1 : 3.8	2.0	
	9	120 + +	134	164	298	1 : 1.22	2.5	
III.	5	266 + +	125	182	312	1 : 1.5	1.17	Free analyt. filter Sprayer operator
	12	330 + +	97	122	219	1 : 1.24	0.66	
IV.	6	121 +	19	80	99	1 : 4.2	0.82	Free analyt. filter Sprayer operator
	11	66 + +	32	101	132	1 : 3.26	2.0	
V.	From I-IV worn 50 mins. Filter 7	660 + +	83	190	273	1 : 2.3	0.41	2nd. assistant
VI.	Unused, packed, check filter 14 and 15	—	—	—	—	—	—	Blank checks

details of the application method, active substance dosages and concentrations, and the test duration for tests I to IV. Table 2 gives the quantities of active ingredient found in the analytical filters and in the respirator filters of the test persons, and the concentrations of METASYSTOX in the air. The calculation of the METASYSTOX concentrations in air from the filter elements of the test persons is based on a breathing volume of 800 litres of air per hour, which corresponds to the degree of heaviness of the work.

The spectrum of the droplet sizes was determined in order of magnitude for the different application techniques by means of the India ink method. An aqueous solution of India ink was added to the active substance emulsions, and these were then sprayed. During the spraying or atomizing process, baryta cartons (DIN A 4 size) were held briefly in the path of the spray jet or mist at the level of the sprayer operator's head and chest. The pattern of the India ink particles was greatly enlarged photographically, and sections of this were evaluated in a special apparatus of the Federal Biological Institute for Agriculture and Forestry, Braunschweig (Dr. Koch). The determination of the particle sizes showed that the distribution curve plotted for the particle sizes was practically the same for all methods of application. The majority of the particles were between 62 and 430 microns in size — the range considered most suitable for crop protection techniques — with a distribution maximum of between 120 and 150 microns. Unfortunately the method of determining the particle sizes used by the Federal Biological Institute, Braunschweig did not permit a differentiation to be made in the toxicologically important range of particle sizes under 62 microns so that only rough estimates are possible in this particular range.

Discussion of the test results

The purpose of carrying out measurements of METASYSTOX concentrations in the air under practical field conditions was to establish whether there is any risk of operators applying the substance METASYSTOX being exposed to health hazards as a result of inhalation or absorption through the skin of the active substance, and whether there are any differences in this respect among the various methods of application. The quantities of METASYSTOX found analytically in the filter elements show that the uptake varies appreciably not only in the different tests but also in the same test. With the exception of test IV, the free analytical filters contained considerably more METASYSTOX than the filter elements breathed into by the test persons. These differences in the content of preparation, which have great influence on the calculation of METASYSTOX concentrations in air, are brought about in that the filtered volume of air was never the same; it was measured exactly only in the free analytical filters by means of a gas meter, and could only be calculated approximately in the filters used by the test persons. Consequently, a uniform value of 800 litres per hour was taken as the basis for the breathing volume. Another reason for the fluctuations is the varying exposure of the different filters, due to the varying distance from the apparatus and the treated object during the movements of the test persons in the compact tree stand. An example of the influence exerted by this factor is given by test IV in which for technical reasons the sprayer operator sat about 3 metres behind the atomizer heads whereas the free analytical filter was even farther away and located about 2 metres above the ground so that the exposure of the filter varied completely. Nevertheless in these two filter analyses there is a somewhat similar ratio between the suspended material portion and the gaseous phase of the active substance, being in favour of the gas phase. Naturally, allowance must be made especially in this test for a certain error in the determination of the concentration due to the short exposure time of 5 mins. and to the fact

that it was impossible to measure the volume of air inhaled through the filter. The ratios between the suspended material portion and the gaseous phase fluctuate not only from test to test but also in the same test as was the case in tests I to III (col. 7, Table 2). It is evident that the gas phase mostly predominates in all forms of application.

When the quantities of active substance (mg/m^3) determined exactly in the free analytical filters are included in the assessment of hazard attached to the different methods, then we find the highest concentration was measured in test II at $3.5 \text{ mg}/\text{m}^3$ (knapsack atomizer) whereby there were five times as many suspended material particles present in the atmosphere as gas particles. The lowest concentration was registered in test IV at $0.82 \text{ mg}/\text{m}^3$ air (motor-powered atomizer), which we attribute to the reasons outlined above. However, when the assessment is based on the quantities of METASYSTOX found in the filters of the test persons, this will give 0.62 and 0.66 mg METASYSTOX per cu. m. of air, respectively, for sprayers (I and III), and 2.5 and 2 mg METASYSTOX/cu. m. air, respectively, for atomizers (II and IV).

Assuming the total quantities given in Table 2, col. 6 (suspended material + gas phase) to be 100 % inhalable and absorbable when examining the question of inhalation hazards to unprotected sprayer operators, and furthermore taking the maximum values (col. 8) determined in tests I—IV and a breathing volume of 800 litres per hour (as above) as a basis, then the theoretical maximum uptake of active substance through the air passages after working periods of 1 and 6 hours will be equal to the values given in Table 3.

Table 3:

Test No.	Col. 8	after 1 hr.	after 6 hrs.
I.	(1.4)	1.12 mg	6.72 mg
II.	(3.5)	2.7 mg	16.2 mg
III.	(1.17)	0.94 mg	5.64 mg
IV.	(2.0)	1.6 mg	9.6 mg

Assuming the toxicity of a substance for uptake through the lungs (inhalation) to be equal quantitatively to its effect for intravenous injections, then certain conclusions can be drawn, at least in order of magnitude, from the intravenous toxicity values determined by Vandekar (27) for METASYSTOX on rats (see Table 4).

On the grounds of these numerical values, the effects of the two METASYSTOX isomers — tested in our previous studies — and their 30:70 mixture in different methods of application on laboratory animals and in inha-

lation trials on voluntary test persons (23, 25), also the inhalation tests of several hours duration on animals carried out by E. Gross (22), it can be assumed with all probability that even the above uptake of active substance, which has purposely been calculated at a high figure, will not lead to traceable symptoms (inhibition of the cholinesterase) in human beings also when repeated several times.

Table 4:

Substance	Toxicity values expressed in mg/kg rat	
	sublethal	lethal
P = S-Metasytox	200	250
P = O-Metasytox	50	75

The determination of the particle sizes showed that when the described methods are applied, more than 90 % of the suspended material particles of METASYSTOX, due to their size, cannot infiltrate into the central and deep air passages (lungs). On the other hand the order of magnitude of the droplets leaves open the possibility of skin wetting because the large and medium-sized droplets, rebounding from treated objects (e. g. trees) or carried back by the wind, are deposited on the unprotected skin of the face, hands and arms. This possibility exists on principle for all four methods of application because our observations have established that the exposure of the operator depends more upon the application technique, the plant and tree stand, and the weather conditions than upon the types of equipment used. But we observed that when dense tree stands were sprayed (test I and III), the clothing was wetted far more considerably than when the atomizing technique was applied (tests II and IV). Wetting of the skin, however, can be reduced to an insignificant minimum by wearing the usual type of working clothing that gives full coverage of the body, and by observing the normal precautionary measures.

II. Toxicological studies on voluntary test persons and on dogs for application of METASYSTOX by atomizing and spraying methods in closed greenhouses (Wiesmoor)

In view of our analytical results outlined in Section I, and on the grounds of animal experiments carried out by other authors and our own previous studies on voluntary test persons and test animals under intensified conditions (23), we considered hazards to sprayer operators who apply METASYSTOX in the field by the tested methods also without wearing face masks,

to be most improbable. But nevertheless, we considered it necessary, from theoretical and practical aspects, to consolidate the conclusions drawn in Section I by carrying out further toxicological investigations. As experimental results obtained in tests on dogs can only be applied with limitations to human beings, we tested — just as in previous experiments (23) — the effect of METASYSTOX on voluntary test persons and dogs under practical conditions. Details of similar investigations, although with other substances, are included in papers published primarily by American authors (29—34).

The purpose of our tests was to establish whether there was any difference in the effect of METASYSTOX when applied by means of the conventional atomizing and spraying methods, and especially to examine the question of hazards to spraying personnel working in closed, warm greenhouses. As it was intended to use the same portable equipment and the same METASYSTOX dosages as described in Section I of this paper, very large, heatable greenhouses were needed for the tests. Thanks to the cooperation of the Nordwestdeutsche Kraftwerks-A. G., Wiesmoor/Ostfriesland, it was arranged for the tests to be carried out in a big block of greenhouses in Wiesmoor, which were fitted with heating and ventilation systems. The laboratory equipment for carrying out the cholinesterase determination (in the Warburg apparatus according to the method of Ammon, 35) and the blood tests was transported together with personnel to Wiesmoor.

Testing technique:

Test area: 4 well-heated greenhouses measuring 3.5 metres in height, 135 metres in length and 8 metres in width (total of 4300 square metres) for atomizing tests; 2 similar greenhouses with a total area of 2150 square metres for spraying tests.

Test equipment: 1 "Holder" type knapsack sprayer, 13 litre capacity, 10 atm. gauge and 1 motor-powered knapsack atomizer ("Solo" type) of 10 litre capacity.

Test persons: 2 groups of 2 men each; dressed in denim suits but not wearing face masks; operating in the spraying and atomizing tests.

Test animals: 1 dog allocated to each group.

Duration of test: 5 consecutive days with 5 working hours each day.

Miscellaneous conditions: Test room temperatures and relative humidity were simultaneously registered several times in all greenhouses by means of graph. During the course of the test day the temperatures fluctuated between 15 and 25°C; during the main working period the temperatures were around 22°C in static air. The relative humidity was between 65 and 85%.

Substance, dosages and method of application: In contrast to the analytical field test with radioactive-labelled preparation (described in the first section of this paper) the commercial product METASYSTOX such as is obtainable on the market (50 parts of emulsifier + 50 parts of METASYSTOX mixture made up of 30% P-O compound and 70% P=S compound) was used in these tests. The two test groups applied in five days (5 working hours each day) a total of 808 litres of a 0.5% active substance concentration in the atomizing test, and 1376 litres of a 0.05% active substance concentration in the spraying test. The spray solutions were evenly applied in the greenhouse according to a plan; the atomizing and spraying operations were interrupted only to refill the sprayer and atomizer tanks, and at midday.

Table 5: Atomizing test. Determination of cholinesterase activity.

Date	Test person: R			S			Dog I		
	Serum Measured value	%	Erythrocyt. Measured value	%	Serum Measured value	Erythrocyt. Measured value	%	Serum Measured value	Erythrocyt. Measured value
19. 10. 56	146.03		115.53		158.89	100.46		109.99	170.37
26. 10. 56	155.29		105.29		153.79	85.90			
mean:	150.66	100.0	110.41	100.0	156.34	93.18	100.0	109.99	170.37
5. 11. 56	137.58	91.3	117.13	106.1	140.35	92.99	89.8	93.72	163.83
6. 11. 56	142.92	94.8	111.14	100.7	148.76	111.88	95.1	79.98	133.62
7. 11. 56	145.83	96.8	112.33	101.7	142.02	101.75	90.8	84.04	120.27
9. 11. 56	151.28	100.4	118.49	107.3	147.34	91.91	98.6	33.65	91.67
16. 11. 56	154.27	102.4	103.02	93.3	133.17	96.96	104.0	77.45	118.03
23. 11. 56					136.24	110.12	118.2	89.63	120.33
30. 11. 56								88.42	122.69
7. 12. 56								92.05	129.60

Table 6: Spraying test. Determination of cholinesterase activity.

Date	Test person: W			F			Dog II		
	Serum Measured value	%	Erythrocyt. Measured value	%	Serum Measured value	Erythrocyt. Measured value	%	Serum Measured value	Erythrocyt. Measured value
19. 10. 56	165.28		126.18		195.24	144.57		87.80	115.42
26. 10. 56	185.05		117.19		189.13	110.34			
mean:	175.17	100.0	121.69	100.0	192.19	127.46	100.0	87.80	115.42
5. 11. 56	155.08	88.5	120.98	99.4	186.99	125.90	97.3	98.30	127.12
6. 11. 56	160.02	91.4	120.02	98.6	189.82	131.30	98.8	93.50	114.84
7. 11. 56	173.16	98.9	116.21	95.5	177.32	115.22	92.9	90.68	98.54
9. 11. 56	169.50	96.8	111.38	91.5	189.40	127.47	98.5	87.50	119.62
16. 11. 56	172.31	98.4	120.51	99.0	191.75	130.12	99.8	93.27	123.82
7. 12. 56								89.66	117.52

Concentration of METASYSTOX in the air: The concentrations determined analytically in a special test series under similar temperature and working conditions (2000 litre volumes of air were sucked through cooled gas-washing bottles with alcoholic caustic soda solution, and the phosphorus content determined against blank samples) amounted to an average of 1.88 mg of METASYSTOX per cubic metre of air (0.19 ppm) for the atomizing tests, and to an average of 0.285 mg of METASYSTOX per cubic metre of air (0.0285 ppm) for the spraying tests.

These METASYSTOX concentrations, which are well below the saturation limit, fully correspond in order of magnitude to the analogous values obtained in the analytical tests described in Section I. This fact is all the more surprising since identical equipment and the same active substance concentrations were used in both test series, and considering that higher METASYSTOX vapour concentrations in air were to have been expected in the warmer, static atmosphere of the greenhouses. We attribute this outstanding fact to the varying working techniques used in both test series; in the tall tree stand the method adopted brought with it considerable rebound and a slower sedimentation of the active substance particles, whereas in the low beds of the Wiesmoor greenhouses sedimentation was faster accompanied by rapid absorption of all particles in the loose, warm peaty soil.

Observations:

The voluntary test persons and the two dogs were kept under observation during and after the tests. The test persons did not complain of any form of ailment either during or after the test period and did not show any perceptible symptoms. The two test animals behaved quite normally.

Blood tests:

The cholinesterase values in the serum and in the erythrocytes were determined for the four test persons twice before the start of the test, four times during the test and 1 or 2 times at the end of the test by means of the Warburg apparatus. The analogous activities of the test dogs were measured once before the start of the test, four times during the test, and again four times at the end of the test. The capacity of the Warburg apparatus restricted the number of animals to two. The results obtained in the determinations of the cholinesterase activities are given in Tables 5 and 6 according to test groups. The haemoglobin content and the number of erythrocytes and leukocytes were also determined for the test persons and the two dogs. Differential blood counts were taken, and the reticulocytes in the blood were counted. By means of the paper-electrophoresis method, a determination was made of the albumin fractions in the serum, and the residual and total nitrogen content in the blood was registered. Whereas the other blood tests showed no fluctuations or changes as compared with the blank values, there was a medium increase in the number of reticulocytes from 6 to 25 per mille for the test persons and dogs both in the atomizing test and in the spraying experiment; the number of erythrocytes remained unchanged. This increase of reticulocytes averaging 400 % had not subsided even after one week. (A detailed report [25] on the blood tests was given in a paper [P f a f f] read at the IV International Plant Protection Congress).

Discussion of test results:

As shown by the cholinesterase values compiled in Tables 5 and 6 for the four test persons, the quantities of METASYSTOX taken in from the air in the greenhouses by inhalation and possible contact with the skin of the face

and hands, were not sufficient despite five hours of exposure each day to have perceptible influence on the cholinesterase activity in the serum and in the erythrocytes. The activity values registered in double measurements do not fluctuate more than $\pm 10\%$ of the individual normal values either for atomizing or for spraying carried out in the conventional manner.

This view is confirmed also by the cholinesterase values — likewise uninfluenced — determined for dog II. The measured decrease of the serum cholinesterase in dog I — and the less pronounced drop in the cholinesterase activity of the erythrocytes — may be attributed to the fact that on the 3rd. day of the test this dog, which had become thirsty as a result of the heat in the greenhouse, broke away from its chain while the sprayer tanks were being filled, and drank 0.5% METASYSTOX active substance solution which had collected in a small pool under the machine. But this dog (I) did not show any perceptible symptoms of poisoning, and its ChE values which had dropped to 30 and 53%, respectively, rose again steadily during the course of the observation period (4 weeks).

In contrast to these negative results of cholinesterase determinations for the test persons and the dogs, it is most interesting to note that there is a marked increase of reticulocytes in flowing blood for the test persons and the dogs in both the atomizing and the spraying tests. As there was neither an increase nor a drop in haemoglobin content and the number of erythrocytes and leukocytes, it must be assumed that a process was involved here which although not having a harmful effect on haemopoiesis did stimulate the latter in a round-about manner; the mechanism of this process deserves further investigation. This ought to show whether in the determination of the reticulocytes in blood we have a method for detecting an initial phosphate effect, which is more sensitive than the long and difficult ChE-determination according to A m m o n. The data obtained for the test persons and for the dogs gave no indication of change in the differential blood count, the albumin fractions of the serum or the nitrogen content of the blood. Therefore, we could not confirm the findings of Klotzsche (36) obtained in his tests with considerably higher dosages of other alkyl phosphates on laboratory animals.

Our results and observations confirm the conclusion drawn in Section I, according to which only slight concentrations of METASYSTOX occur in the air at the site of application when normal methods of application are used. These concentrations did not cause any perceptible disturbances or measurable inhibition of the cholinesterase activity either in the voluntary test persons or in the dogs exposed to spray applications (spraying and atomizing techniques) in closed, warm greenhouses for several days (and not provided with face masks); they did, however, bring about a marked increase of the reticulocyte values in flowing blood, which persisted for at least one week. The reason for this latter condition cannot yet be explained, but it is intended to clarify it in later studies.

Summary:

A series of tests were conducted under practical conditions with the purpose of examining the question of hazards to operators applying the insecticide 0,0-dimethyl-(ethyl-thioethyl)-thiophosphate (METASYSTOX® *).

* ® — Registered trade mark of Farbenfabriken Bayer Aktiengesellschaft, Leverkusen.

Concentrations of METASYSTOX occurring in the air were analytically determined in field tests (with conventional application techniques) and at normal dosages under given weather conditions) for low volume atomizing and spraying, the most important application practices. Whereas the separately determined suspended material portion and the gaseous portion of METASYSTOX changed constantly in both methods, and the slight concentrations formed with sprayers and mobile atomizers were similar in order of magnitude, the use of knapsack atomizers in densely growing stands of tall trees appears to lead to somewhat higher concentrations of active substance in the air. It is estimated that in all four methods, less than 10 % of the measured aerosol particles were smaller than 62 μ .

The presence of a low METASYSTOX content in the air was confirmed by toxicological tests conducted in large, heated greenhouses. The strenuous application of METASYSTOX on several consecutive days in warm, static air led neither to perceptible, general or nervous disturbances nor to measurable decreases in the cholinesterase activity on any of the four unprotected test persons (this also applies to the two dogs included in the tests); it did, however, bring about a marked increase of the reticulocyte values. The mechanism of this latter requires further explanation.

Under practical conditions, especially in the open field, the level of the concentration of METASYSTOX in the air appears to be governed more by the working technique — which in turn is determined by the plant being treated — and by the atmospheric conditions than by the actual method of application employed; moreover the maximum concentration admissible for the site of application is not exceeded.

Finally, we would once again express our sincere thanks to all persons, institutes and organizations concerned for their valuable cooperation and assistance in these tests: Farbenfabriken Bayer Aktiengesellschaft, Crop Protection Laboratories, Elberfeld, and Crop Protection Research Department, Leverkusen, Crop Protection Office Bonn, (technical division), Horticultural Research Station, Friesdorf-Bad Godesberg, Federal Biological Institute for Agriculture and Forestry, Braunschweig, the Nordwestdeutsche Kraftwerks-A.G., Wiesmoor (Ostfriesland), and the female technical assistants of the Pharmacological Institute, Bonn University.

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Correction

Regarding the article "The Possibilities of Control of Jute Semi-looper (*Anomis sabulifera* Guen.) by "Folidol-E 605" in the Höfchen-Briefe, No. 2/1957, page 95.

- ✓ 1. The senior author of this article is Dr. Dutt, Entomologist, whose name has been omitted inadvertently; we very much regret this mistake. The address of Mr. Dutt is: N. Dutt, Jute Agricultural Research Institute, Barrackpore, W. Bengal, India.
- ✓ 2. We would ask our readers to delete the following two sentences on page 95.
Section 1, line 4:
"Seeds are usually sown during March-April and the crop becomes ready for harvest in September-October."
Section 2, line 6 and 7:
"The caterpillars come out within 2—3 days and pass through three moults and pupate inside the soil."
- ✓ 3. The "Scientific Department, Indian Tea Association", Tocklai India, is not responsible for the above-mentioned article.

The editors.

